

HYPERTENSIVE VASCULAR DISEASE

Hypertension is a major global health problem, particularly prevalent in higher-income countries.

Despite its serious consequences, it is often clinically silent for years, earning it the title of a “silent killer” .

Forms & Terminology of Hypertension

Primary (Essential / Idiopathic / Benign) Hypertension

- Represents the most common form
- Typically asymptomatic for many years
- Historically called “benign” or “essential” because:
 - BP was thought to rise with age to maintain organ perfusion (especially brain)
-  This belief is incorrect

🔑 Modern concept:

These BP increases are neither essential nor benign →

Preferred term: Primary hypertension (idiopathic)

Why Primary Hypertension Is Dangerous

Even without symptoms, chronic hypertension leads to:

- Stroke
 - Atherosclerotic coronary heart disease
 - Left ventricular hypertrophy → heart failure
(hypertensive heart disease)
 - Aortic dissection
 - Multi-infarct dementia
 - Chronic renal failure   
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Etiology of Hypertension

Distribution of Causes

Type of Hypertension	Approx. Frequency
Primary (Idiopathic)	~95%
Secondary	~5%

Common Causes of Secondary Hypertension

- Primary renal disease
- Renal artery stenosis (renovascular hypertension)
- Adrenal disorders
- Obstructive sleep apnea

 Exam tip:

Always think renal causes first in secondary hypertension.

Prognosis

- Primary hypertension → Compatible with long life unless complications develop
 - Secondary hypertension → Prognosis depends on successful treatment of underlying cause
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Epidemiology of Hypertension

Blood Pressure as a Continuous Variable

- Like height and weight, BP shows continuous distribution
 - Risk increases progressively with rising BP
 - No absolute "safe" threshold 
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Clinical Diagnostic Cutoffs

Used in population studies and clinical practice:

- Systolic BP > 120 mm Hg
- Diastolic BP > 80 mm Hg

→ Associated with increased risk of atherosclerosis

⚠ *Important:*

These cutoffs are somewhat arbitrary

→ Lower thresholds may apply in high-risk patients (e.g., diabetes)

Prevalence

- 40% of adults in the U.S. meet criteria for hypertension
 - Prevalence and severity:
 - Increase with age
 - Are higher in certain populations
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Population Differences

- Hypertension-related disease burden is:
 - Lower in high-income countries
 - Higher in low-income countries

- In the U.S.:
 - African Americans have the highest prevalence
 - Due to genetic + environmental factors
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Natural History & Mortality

Untreated Hypertension Outcomes

Without appropriate treatment:

- ~50% die of:
 - Ischemic heart disease (IHD)
 - Congestive heart failure
- ~33% die of:
 - Stroke 

Impact of Treatment

- Blood pressure reduction:
 - ↓ incidence
 - ↓ morbidity

- ↓ mortality
of all hypertension-related diseases 
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Malignant (Severe) Hypertension

Definition

A small subset (~5%) of patients develop:

- Rapidly progressive hypertension
- Leads to death within 1-2 years if untreated

Blood Pressure Criteria

- Systolic > 180 mm Hg
 - Diastolic > 120 mm Hg
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Pathologic Consequences

Severe morbidity due to:

- Renal failure

- Retinal hemorrhages
 - ± Papilledema 
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Development Pattern (Flowchart):

Long-standing primary hypertension → Sudden marked BP elevation → Malignant hypertension → Vascular injury + end-organ damage → Renal failure / retinal changes → Death (if untreated) 

 Key point:

Malignant hypertension:

- Can arise de novo
 - More commonly superimposed on preexisting “benign” hypertension
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Exam Pearls 

- ~95% hypertension is primary (idiopathic)
- “Benign” hypertension is neither benign nor essential

- Hypertension is often asymptomatic for years
 - Major causes of death:
 - IHD
 - CHF
 - Stroke
 - Malignant hypertension = medical emergency
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Pathogenesis of Primary Hypertension

Although the molecular regulators of blood pressure are well understood, the exact mechanisms leading to primary hypertension in most patients remain unknown.

Central Concept

Primary hypertension results from a complex interplay of genetic predisposition and environmental influences, which together lead to:

- ↑ Blood volume
- and/or ↑ Peripheral vascular resistance

➔ Result: Sustained elevation of blood pressure 

Key Pathogenic Mechanisms

I. Altered Renal Sodium Handling (MOST IMPORTANT) 

 Core abnormality:

Reduced renal sodium excretion at normal arterial pressure

This is a shared pathogenic feature of most forms of hypertension.

Sodium Retention Mechanism (Flowchart):

Normal BP → ↓ Renal sodium excretion → Obligatory water retention → ↑ Blood volume → ↑ Cardiac output → ↑ Blood pressure

At higher BP: → Kidneys excrete more sodium → New steady state achieved → BUT at an elevated BP 

 Exam phrasing:

“Primary hypertension represents a reset of the pressure-natriuresis relationship to a higher blood pressure.”

2. Increased Vascular Resistance

May occur due to:

- Functional vasoconstriction
- Structural remodeling of vessel walls

These mechanisms are interrelated, not independent.

Vascular Remodeling (Flowchart):

Chronic vasoconstriction → Sustained hemodynamic stress → Smooth muscle cell hypertrophy → Increased ECM deposition → Permanent vessel wall thickening → Fixed ↑ peripheral resistance

→ Maintains hypertension even if vasoconstrictor stimuli lessen 

3. Genetic Factors

Strong evidence for genetic contribution:

- Familial clustering
- Higher concordance in monozygotic twins than dizygotic twins

Susceptibility Genes Likely Involve

- Renal sodium reabsorption
- Endogenous pressor production
- Vascular smooth muscle cell growth

 Specific genetic links (minority of cases):

- Angiotensinogen polymorphisms
- Angiotensin II receptor variants
- Renin-angiotensin system polymorphisms

 *Clinical relevance:*

These polymorphisms partly explain population-based BP differences.

4. Environmental Factors

Environmental influences modify genetic risk and promote disease expression.

Major Environmental Contributors

- Chronic stress
- Obesity
- Smoking
- Physical inactivity
- High dietary sodium intake 
- Poor access to healthcare

 Strongest evidence:

Dietary sodium intake ↔ hypertension

Overall Pathogenesis Summary:

- Genetic susceptibility
 - Environmental triggers
 - ↓ Renal sodium excretion
 - ↑ Peripheral resistance
 - ↑ Blood volume
 - Sustained primary hypertension
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Morphology of Hypertensive Vascular Disease

Hypertension causes progressive vascular damage, affecting vessels of all sizes.

Major Effects

- Accelerated atherosclerosis
 - Degenerative changes in:
 - Large arteries → aortic dissection
 - Cerebral vessels → intracerebral hemorrhage
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Small Vessel Disease in Hypertension

Two characteristic patterns are recognized:

I. Hyaline Arteriolosclerosis

Association

- Primary (benign) hypertension
 - Also seen in diabetes mellitus
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Morphologic Features

- Homogeneous, pink hyaline thickening
 - Loss of normal vessel wall detail
 - Luminal narrowing
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Pathogenesis (Flowchart):

Chronic hypertension → Endothelial injury → Plasma protein leakage into vessel wall

- SMC ECM production → Hyaline deposition → Arteriolar wall thickening → Luminal narrowing
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Renal Involvement

- Arteriolar narrowing → Diffuse renal ischemia → Nephrosclerosis → Glomerular scarring 

 Exam note:

- Seen in aging normotensive individuals
 - More severe and generalized in hypertension
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2. Hyperplastic Arteriolosclerosis

Association

- Severe or malignant hypertension

Morphologic Features

- Concentric, laminated thickening
- "Onion-skin" appearance 🍷
- Marked luminal narrowing

Structural Composition

- Smooth muscle cell proliferation
- Thickened, reduplicated basement membranes

Malignant Hypertension Changes (Flowchart):

Severe / Malignant Hypertension → Sudden marked increase in pressure → Endothelial damage + smooth muscle growth signals → Concentric smooth muscle hyperplasia → Basement membrane duplication → "Onion-skin" appearance → Severe luminal narrowing →

Acute organ ischemia → Possible fibrinoid necrosis (in severe cases) ⚠

Comparison Table: Small Vessel Lesions

Feature	Hyaline Arteriosclerosis	Hyperplastic Arteriosclerosis
Seen in	Primary HTN, diabetes	Severe/malignant HTN
Appearance	Pink, homogeneous	Onion-skin, laminated
Mechanism	Plasma leakage + ECM	SMC proliferation
Luminal narrowing	Gradual	Marked
Fibrinoid necrosis	✗	✓ (malignant HTN)

Types and Causes of Hypertension

Primary Hypertension

- 90-95% of cases
 - Idiopathic
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Secondary Hypertension

Renal Causes

- Acute glomerulonephritis
 - Chronic renal disease
 - Polycystic kidney disease
 - Renal artery stenosis
 - Renal vasculitis
 - Renin-producing tumors
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Endocrine Causes

- Cushing syndrome

- Primary aldosteronism
 - Congenital adrenal hyperplasia
 - Pheochromocytoma
 - Acromegaly
 - Hypothyroidism
 - Hyperthyroidism
 - Pregnancy-induced (preeclampsia)
 - Exogenous hormones (steroids, OCPs, sympathomimetics, MAOIs)
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Cardiovascular Causes

- Coarctation of aorta
 - Polyarteritis nodosa
 - Increased intravascular volume
 - Increased cardiac output
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Neurologic Causes

- Psychogenic
 - Increased intracranial pressure
 - Obstructive sleep apnea
 - Acute stress (e.g., surgery)
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EXAM PEARLS

- ↓ Sodium excretion at normal BP is central to primary HTN
 - New sodium balance achieved only at higher BP
 - Hyaline arteriosclerosis → benign HTN
 - Hyperplastic arteriosclerosis + fibrinoid necrosis → malignant HTN
 - Kidneys are the most consistently affected organs
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-> The End <-